bility of spatial differentiation in the assessment of impacts on ecosystems still remains a largely unaddressed issue – here as well as elsewhere.

The final chapter of the book illustrates the use of the integrated methodology on three additional cases. The strength of this book clearly lies in cases where dominant contributions to the overall impact or damage come from one or a few well known processes for which conditions of receiving environments can be known. Here, the integration of ERA and LCA can provide impact or damage predictions which are much better in accordance with what actually happens. In LCAs of ordinary products, where many processes contribute significantly, the data requirement of the integrated approach will be hard to meet. Hence, the focus on industrial process chains – an application between conventional LCA and ERA.

Overall, the book provides a good introduction to LCA and ERA, and some interesting work on the integration of the two. Its main message concerns the possibilities and relevance of site-specific and site-dependent risk assessment, not just for individual processes (in which case we are talking about ERA) but also for shorter industrial process chains, i.e. geographically well-localised parts of life cycles.

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New LCA Theses

Environmental Damage Estimations in Industrial Process Chains

Ph.D. thesis by Guido W. Sonnemann, Universitat Rovira i Virgili, 2002

Methodology development with a case study on waste incineration and a special focus on human health

Environmental damage estimations in industrial process chains need the assessment of environmental impacts in two perspectives: process chain-orientated and site-orientated. Environmental assessment tools exist for both perspectives: Life Cycle Assessment (LCA) and Environmental Risk Assessment (ERA). LCA is a fairly new chain-orientated tool to evaluate the environmental performance of products focussing on its entire life cycle. In the Life Cycle Impact Assessment (LCIA) phase, a product system's Life Cycle Inventory (LCI) results are evaluated to better understand their environmental relevance. ERA is a tool to assess the risk of chemicals. In the exposure analysis, the risk of a process at one location is evaluated. The Impact Pathway Analysis (IPA) is a method related to ERA that has been developed for the assessment of environmental damages by the terms of physical impact parameters like cancer cases. In the IPA, the physical impact parameters are usually converted into external environmental costs, but individuals may prefer other existing weighting schemes to express different types of environmental damages depending on personal values.

Products are manufactured in a ramified chain of processes. While specific tools exist for the environmental assessment of products and processes, this is not the case for the assessment of a number of industrial processes with a common functional unit such as end-of-life cycles. However, the level of sophistication in the assessment can be much higher for industrial process chains with a quite limited number of processes involved than for the life cycles of complex products. Only little efforts have been made so far to systematically explore the inherent uncertainties, interfaces and possibilities for integration and communication of the chain-orientated and site-orientated environmental assessment methods in the case of such industrial process chains. Therefore, the objective of this thesis is to find an adequate trade-off between process chain-orientated and site-orientated environmental impact assessment and to convert environmental damage estimates into meaningful results like environmental costs.

The thesis proposes a mathematical framework and a flowchart that allows spatial differentiation at different levels of detail based on the integration of LCA, ERA and IPA with environmental costs. This methodology, called 'Environmental Damage Estimations in Industrial Process Chains', puts the conventional, potential midpoint LCIA indicators in a common framework with damage, endpoint IPA indicators. As a trade-off between site-specific damage assessments and potential life cycle indicators, a currently existing site-dependent impact assessment is further developed and integrated in the methodology proposed. The site-dependent impact assessment method is based on statistical reasoning and uses representative, generic impact classes corresponding to receptor distribution and dispersion conditions. As part of the methodology development, uncertainties in the LCI and IPA are analysed using Monte Carlo Simulation. This parallel analysis permits one to show that the uncertainties in the inventory analysis are less important than those in the damage assessment.

The methods presented and the methodology developed were successfully applied in several ways to a case study on waste incineration with a special focus on human health. In a comparison of the results obtained by endpoint indicators with midpoint indicators, it was found for the situation of the case study that the midpoint indicators apparently underestimate the environmental impact of the transport processes. A new generation of integrated waste management tools seems to be feasible that takes into account the setting of the waste treatment installations and the sites affected by the transport routes, allowing in this way an overall environmental optimisation.

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